

# PATENT SPECIFICATION

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## (54) COMPRESSIBLE PRINTING PLATE MOUNT

(7i) We, MINNESOTA MINING AND MANUFACTURING COMPANY, a corporation organised and existing under the laws of the State of Delaware, United States of America, of 3M Center, Saint Paul, Minnesota 55101, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to mounting materials for flexographic letterpress printing plates and to methods for forming same.

In letterpress printing, an impression printing element (either an impression roll or an impression plate) is inked and thereafter applied to paper or other sheet stock to be printed to create a printed copy. In the flexographic letterpress printing, the impression plate is precisely molded of an elastomeric material (typically rubber) and the ink is fluid, unlike more typical letterpress printing, which employs a paste-like ink. The combination of a flexible printing plate and fluid ink provides a printing system which can produce copies at an extremely high rate, at printing speeds as high as 1,000 feet (300 meters) per minute and typically between 300 and 700 feet (90 and 280 meters) per minute.

The quality of the resultant printed copy from a flexographic letterpress printing system is not only very dependent upon maintaining accurate control of the printing plate thickness but also upon maintaining extremely close tolerances in the printing equipment itself, especially the tolerances between the printing plate and the inking surface and the impression plate and the printed copy surface. Variation in flexographic printing plate (typically about 100 to 150 mils —2.5

to 3.7 mm— thick) greater than 1 mil (25 microns) cannot be tolerated.

Not only must the thickness of the printing plate be maintained with extreme accuracy, but all the elements going to form the impression roll must also be so maintained. The plate cylinder to which the printing plate is attached must have a smooth surface and uniform diameter throughout its length. The material used to mount the printing plate upon this roll also be of uniform thickness and capable of maintaining such uniform thickness throughout the entire printing operation.

During printing, it is important to have intimate contact between the printing plate surface and the paper to produce a clean sharp copy. This is ordinarily achieved by positioning the printing plate and the back-up cylinder or (other surface which the plate contacts) so that there is a uniformly constant impression between the two. If certain areas of the printing plate do not have uniform impression against the paper being printed, discontinuity in the printed copy will result. Increasing the press settings to obtain a greater overall impression has resulted in a distortion of the copy in areas where the impression was originally adequate because neither the printing plate nor the mounting material has been sufficiently compressible to compensate for such adjustment. Too much impression has caused the cylinder to bounce in use, resulting in damage to the entire press, limited the press speed because of the additional friction in the system, and drastically reduced the printing plate effective use life.

While attempts have been made to produce compensating compressible flexographic printing plate mounts, no suitable mount has been made to solve the deficiencies noted above. To get adequate

compression, some mounts are required to be so thick that they increase the effective diameter of the impression roll to such an extent that they cannot be used within the adjustability range of a conventional letterpress. Others, for example, those using blown sponge as a compressible layer, are so compressible that they fail to maintain the proper pressure settings within the flexographic letterpress to produce uniform clean copies. Others are too weak to withstand the shear forces encountered at the impression drum surface during printing. Still others are insufficiently compressible to give the compensation desired in printing plate mount.

The present invention aims to provide a flexographic printing plate mount which will have sufficient strength and integrity to hold the printing plate in place for long periods of use, which is strong yet flexible and conformable, which can be temporarily compressed to a substantial extent, but which is highly resistant to permanent damage.

According to the invention, a compressible mounting material suitable for supporting a flexographic letterpress printing plate upon a plate cylinder comprises in laminated combination: an elastomer layer having at least 30 percent uniformly distributed voids, said elastomer layer having a Shore A-2 hardness value of at least 20 when void free, each void having a maximum dimensions of less than 300 microns, a shape corresponding to a minute rigid-walled frangible bubble, and containing the broken walls of said bubble; a dimensionally stable reinforcing layer adherently bonded to the elastomer layer, and a pressure-sensitive adhesive layer adherently bonded to each exposed major surface of the laminate.

Compressibility is imported to the material of the invention by virtue of the frangible rigid-walled bubbles that have been broken uniformly throughout the layer. The bubbles are selected so that they have sufficient wall strength to withstand processing during formation of the elastomer layer, yet they are fragile enough to rupture upon being subjected to a sufficiently high pressure. After the bubbles are ruptured, the elastomeric compressible layer resembles a low void volume closed-cell foam which provides a smooth surface for adhering to the remaining layers.

A method according to the invention for forming a mounting material of the above kind comprises the steps of:

forming a elastomer layer having uniformly distributed and permanently bonded therein a multiplicity of rigid-walled frangible bubbles, each having a maximum dimension of less than 300

microns, the total void volume of the bubbles being at least 30% of the volume of the layer and the elastomer having a Shore A2 hardness value of at least 20 when void free;

breaking sufficient bubbles uniformly throughout the elastomer layer to make it compressible;

permanently laminating together the compressible elastomer layer and a dimensionally stable reinforcing layer;

and laminating a layer of pressure-sensitive adhesive to each exposed major surface of the resultant structure.

In one embodiment of the invention, the reinforcing layer is a non-woven fabric. A preferred such fabric is of nylon and has a grab tenacity of at least 15 pounds per inch width. In another embodiment, the reinforcing layer is a sheet of plastics film which has been biaxially oriented and heat-set. In any event, it is preferred that the thickness of the reinforcing layer is in the range of 1 to 5 mils.

An embodiment of the invention will now be described with reference to the accompanying schematic drawings therein:

Fig. 1 is a diagrammatic section of a printing plate mount according to the invention, and

Fig. 2 is a diagrammatic section of the printing plate mount mounted in a printing press in a typical use situation.

In Figure 1, printing plate mount 10 comprises resilient compressible elastomeric layer 11 which is adherently bonded to tough strong reinforcing layer 12, having pressure-sensitive adhesive layers 14 and 15 adherently bonded to each exposed major surface of the 2-layered laminate.

In use, mount 10 is adhered to the smooth surface 20 of the plate cylinder 21 by one pressure-sensitive adhesive layer 14 while the other pressure-sensitive adhesive layer 15 is adhered to and supports printing plate 22. A copy sheet 23 is shown receiving the previously inked image of raised portions 24 of printing plate 22 as it is pressed between plate cylinder 21 and back-up roll 25.

The compressibility of layer 11 is very important since almost all of the compression which occurs will take place in this layer, and the composition of layer 11 is the key to the invention. A 20-mil (5 mm) thick compressible layer will compress about 3-5 mils (0.08-0.13 mm) under a loading of 60 psi (4 kg per sq cm) (typical printing pressure), and an additional 4-6 mils (0.1-1.5 mm) when loading is increased to 250 psi (17.6 kg per sq cm). Additionally, the compressible layer will not retain a permanent compression or set of

more than about 2 mils (50 microns) when the pressure is decreased from 250 psi (17.6 kg per sq cm) back to 6 psi (10.4 kg per sq cm). The compressible layer is made of an elastomer having a Shore A-2 hardness value of at least 20 and preferably less than 40. If the hardness of the elastomer is significantly below 20, the resultant mount is too soft to maintain a proper press setting. Elastomeric having a hardness value above 40 provide compressible layers which can be too rigid to be compressed to the required degree to provide the necessary compensation.

Compressible layer 11 should have a total void volume of at least 30 percent to obtain the properties described above. If the void volume is less than 30 percent, it is difficult to obtain the necessary compression in this layer. A void volume exceeding 50 percent, although desirable in some applications, can be difficult to produce by the method disclosed herein.

The elastomer should not be so stiff as to require extreme process conditions (e.g., high shear mixing) to blend it with the minute bubbles or else the bubbles will be broken during processing. Preferably the components which react to form the elastomer are liquid or the elastomer itself can be rendered liquid, e.g., by heating, to facilitate processing. Useful elastomers for this purpose include polyurethane, poly(acrylonitrile/butadiene), and polychloroprene. Polyurethane elastomers are preferred.

The thickness of the compressed layer will usually vary within the range of 10 to 30 mils (0.25 to 0.75 mm) (preferably 15 to 25 mils, 0.38 to 0.63 mm). Almost all the compression which occurs will take place in this layer, and if the thickness is less than 10 mils (0.25 mm), we doubt if the necessary compressibility can be secured in this layer alone. In a typical mounting material of the invention, the elastomer layer has a thickness of 15 to 25 mils; the reinforcing layer a thickness of 1 to 5 mils; and each layer of adhesive a thickness of substantially 2 mils.

A critical feature of this invention is that the voids in the compressible layer of the mount are provided by a vast number of minute frangible rigid-walled bubbles. The most preferred rigid-walled frangible bubbles for this purpose are spherical, but bubbles having other shapes, e.g., tubular or pear shape, are also useful. Bubbles of glass or phenolic resin have been found to give excellent results.

Although the size of the rigid-walled frangible bubbles may vary over a wide range, we employ bubbles having a maximum dimension of less than 300 microns, preferably at least 10 microns, in diameter. Since bubbles within the range of

10 to 150 microns are readily available, they are most frequently employed in practicing this invention. The wall thickness of the bubbles may vary; but generally should not exceed about 15 percent of the size of the bubble in terms of diameter. Bubbles of different diameters will have different crushing resistances; therefore, it may be desired, for convenience in processing, to employ bubbles within a narrow diameter range, for example, between about 40 and 100 microns in diameter.

To prevent the rigid-walled bubbles from being crushed in processing, they are preferably capable of withstanding collapse under the continuous hydrostatic pressure of at least 200 psi (14 kg per sq cm), preferably at least about 300 psi (21 kg per sq cm). A mass of bubbles is considered to withstand such pressure if no more than about 10 percent of the original volume of the bubbles is collapsed under such pressure.

It is also preferred that the bubbles are chosen so that at a hydrostatic pressure of about 2000 psi (140 kg per sq cm), substantially all will be collapsed. Any bubbles remaining unbroken in the compressible layer will thereafter remain as filler. It is the individual bubbles which collapse to satisfy the foregoing requirements, and it should be recognized that a bubble collapsed in terms of percentage of original volume cannot reach 100 percent because some of the original volume of frangible bubbles is accounted for by wall thickness. Thus, even after collapse of all the frangible bubbles, the volume still occupied by the fragments of crushed bubbles is such that the highest percentage of void volume obtainable is about 90 percent of the total bubble volume.

In the structure of the printing plate mount of the invention is included a reinforcing layer adherently bonded to the compressible layer. The reinforcing layer will normally be dimensionally stable and of uniform thickness. The reinforcing layer is preferably either a strong, low-stretch non-woven fabric such as may be formed of nylon or polyester or a biaxially oriented plastics film such as polyethylene terephthalate film, although sheets of any of a variety of tough flexible material such as woven fabric, metal or plastics are also useful. The reinforcing layer should be thin, i.e., of the order of 1—5 mils (25—125 microns), so as not to unduly increase the thickness of the mounting material or require a reduction in the thickness of the compressible layer. The reinforcing material preferably has a tensile strength (if it is a film) or a "grab tenacity" (if it is a

5 fabric) of at least 10 pounds per inch (1.8 kg per cm) sample width and preferably at least 15 pounds per inch (2.7 kg per cm) to provide sufficient strength. "Grab tenacity" is determined by first clamping a 4 inch (10 cm) by no less than 6 inch (15 cm) fabric sample in the jaws of an "Instron" tensile testing device. The sample is clamped on its 4 inch (10 cm) sides with a 1 by 1 inch (2.5 cm by 2.5 cm) jaw centered on end end and a 1 by 2 inch (2.5 by 5 cm) jaw centered with the 2 inch (5 cm) side on the other end with a 3 inch (7.5 cm) separation between the opposed jaws. The jaws are then separated at the rate of 12 inches (30 cm) per minute and the force between the jaws measured until the sample fails. A reinforcing material which has been found to be quite acceptable is a spun bonded nylon non-woven fabric sold under the trade designation "Cerex". This material has a grab tenacity of about 19 pounds per inch (3.4 kg per cm).

25 The pressure-sensitive adhesive used to form the adhesive layers on each exposed surface of the printing plate mount are any of many such adhesives known for this purpose which have the well known four-fold balance of adhesion cohesive strength, stretchiness and elasticity. A particularly preferred variety of such pressure-sensitive adhesives are the acrylate type adhesives.

35 While the mounting material of the invention has been suggested to attach flexographic letterpress printing plates onto press cylinders, it may also be advantageously used to attach any molded elastomer printing plate to its press cylinder or support.

40 The following detail examples are offered to further illustrate the invention. All parts are by weight unless otherwise specified.

#### Example 1

45 A compressible flexographic printing plate mount was prepared using a 1-mil (25 micron) biaxially oriented polyethylene terephthalate reinforcing sheet, a 27-mil (0.68 mm) 40% void volume polyurethane compressible layer and two 2-mil (50 micron) layers of acrylate copolymer pressure-sensitive adhesive, according to the description that follows:

	Ingredients	Parts
	Polyurethane—Part A	
55	Polypropylene glycol (M.W. 2000)	42.0
	Polypropylene triol (M.W. 1600)	7.0
60	Finely divided silica ("Cab-O-Sil" M5)	0.43
	1,4-butanediol	0.43
	Diocetyl phthalate	17.6
	Phenyl mercuric oleate	0.85

#### Polyurethane—Part B

	Toluene di-isocyanate	8.03	65
	Polypropylene glycol (M.W. 440)	3.22	
	Sucrose acetate isobutyrate	3.55	
	Ethyl alcohol	0.39	
	Frangible Glass Bubbles		70
	Average size 40 microns		
	Average specific gravity 0.2	16.5	

The polyurethane elastomer produced from parts A and B had a Shore A hardness of 29, when void free.

75 The glass bubbles were intimately mixed with the "A" ingredients in an evacuated vessel to form an "A" slurry. The "B" ingredients were then mixed with the "A" slurry and the resultant mixture was knife-coated at a wet thickness of about 40 mils (1 mm) onto the polyester surface of a 1-mil (25 micron) thick polyethylene terephthalate film adherently bonded to a 2-mil (50 micron) thick layer of acrylate copolymer pressure-sensitive adhesive protected with a release liner. The coating was cured to a non-tacky state by heating for about 4 minutes at about 250°F (120°C). Complete cure was obtained by allowing the composite to age for at least two days at room temperature before additional processing.

90 The resultant cured composite was ground on its polyurethane surface to a uniform thickness of 30 mils (0.75 mm) (without the release liner). The bubbles in the result composite film were crushed by passing the film through a pair of nip rolls which were set with about 500 lbs. pressure per inch (90 kg per sq cm) of width. Following crushing, a 2-mil (50 micron) layer of pressure-sensitive adhesive was applied to the ground face, giving the final product a thickness of 32 mils (0.8 mm) (without the liner).

95 When the finished product was subjected to pressure, compression of 5 mils (125 microns) was obtained as pressure was increased from 6 to 60 psi (0.4 to 4 kg per sq cm). An additional compression of 6 mils (150 microns) was obtained by further increasing the pressure from 60 to 250 psi (4 to 17.6 kg per sq cm), with a set of 0.8 mil (20 microns) resulting when the pressure was returned to 6 psi (0.4 kg per sq cm).

115 The resulting compressible printing plate mount was used to mount a flexographic printing plate approximately 0.093 inch (2.35 micron) thick in a conventional flexographic letterpress. The press had an 18 inch (46 cm) print circumference cylinder, the printing plate was 4 1/4 inches x 6 1/4 (11.4 cm x 16.5 cm) and the mounting material extended one inch (2.5 cm) beyond the dimensions of the printing

plate. The plate so mounted was utilized to print 140,000 feet (43,000 m) of 3-mil (75 micron) polyethylene film with a run time of approximately 9 hours. The print quality was excellent, vastly improved over a similar run using a blown foam plate mounting material sold under the trade designation "Cushion Sticky Back".

### Example 2

Ingredients	Parts
Polyurethane—Part A	
Polypropylene glycol (M.W. 2000)	40.69
Polypropylene triol (M.W. 1600)	7.09
1,4-butanediol	1.75
Finely divided silica ("Cab-O-Sil" M5)	0.42
Diocetyl phthalate	16.55
Phenyl mercuric oleate	0.75
Frangible Glass Bubbles	
Average size 40 microns	
Average specific gravity—0.2	16.33
Polyurethane—Part B	
Methylene diisocyanate	14.19
Tripropylene glycol	1.28
Polypropylene glycol (M.W. 2000)	0.95

Following the procedure of Example 1, a compressible printing plate mount was prepared with a 40% void volume compressible layer formed on the ingredients shown above. The void free elastomer had a Shore A hardness of 29. The resulting compressible printing plate mount was utilized to mount to 73-mil (1.8 mm) thick 5x14 inch (12.7x35 cm) flexographic plates onto a 10 1/4 inch (27 cm) print circumference cylinder using a 10 1/4 by 16 inch (26 by 41 cm) portion of mounting material. The plate thickness varied 2 mils (50 microns), a condition which heretofore would have been completely intolerable because a portion of the copy would not have been printed. The aforementioned equipment was used to successfully print 2-mil (50 microns) Cellophane film at a rate of 500 feet (150 m) per minute ("Cellpham" is a registered Trade Mark).

### WHAT WE CLAIM IS:—

1. A compressible mounting material suitable for supporting a flexographic letterpress printing plate upon a plate cylinder, comprising in laminated combination: an elastomer layer having at least 30 percent uniformly distributed voids, said elastomer layer having a Shore A-2 hardness value of at least 20 when void free, each void having a maximum dimension of less than 300 microns, a shape

corresponding to a minute rigid-walled frangible bubble, and containing the broken walls of said bubble; a dimensionally stable reinforcing layer adherently bonded to the elastomer layer; and a pressure-sensitive adhesive layer adherently bonded to each exposed major surface of the laminate.

2. A mounting material according to Claim 1 wherein the elastomer has a Shore A hardness value of no more than 40, when void free.

3. A mounting material according to Claim 1 or Claim 2 wherein the void volume in the elastomer layer does not exceed 50 percent.

4. A mounting material according to any preceding Claim wherein each void has a maximum dimension in the range 10 to 150 microns.

5. A mounting material according to any preceding Claim wherein the elastomer is one of polyurethane (poly(acrylonitrile/butadiene) and polychloroprene.

6. A mounting material according to Claim 5 wherein the elastomer is a polyurethane elastomer.

7. A mounting material according to any preceding Claim wherein the reinforcing layer is a non-woven fabric.

8. A mounting material according to Claim 7 wherein the reinforcing layer is a nylon non-woven fabric having a grab tenacity of at least 15 pounds per inch width.

9. A mounting material according to any of Claims 1 to 6 wherein the reinforcing layer is a sheet of plastics film which has been biaxially oriented and heat-set.

10. A mounting material according to any preceding Claim wherein the reinforcing layer has a thickness of 1 to 5 mils.

11. A mounting material according to any preceding Claim wherein the minute bubbles are formed of glass or phenolic resin.

12. A mounting material according to any preceding Claim wherein the elastomer layer has a thickness of 15 to 25 mils; the reinforcing layer a thickness of 1 to 5 mils; and each layer of adhesive a thickness of substantially 2 mils.

13. A mounting material according to any preceding Claim wherein the pressure-sensitive adhesive is an acrylate copolymer.

14. A mounting material suitable for supporting a flexographic printing plate upon a plate cylinder substantially as described herein with reference to the accompanying drawing.

15. A mounting material suitable for supporting a flexographic printing plate upon a plate cylinder substantially as herein described with reference to the examples.

16. A flexographic printing plate mounted on a plate cylinder with a mounting material according to any preceding Claim.
- 5 17. A method of forming a compressible mounting material suitable for supporting a flexographic printing plate to the surface of a plate cylinder, comprising the steps of:
- 10 forming an elastomer layer having uniformly distributed and permanently bonded therein a multiplicity of rigid-walled frangible bubbles, each having a maximum dimension of less than 300 microns, the total void volume of the bubbles being at least 30% of the volume of the layer and the elastomer having a Shore A-2 hardness value of at least 20 when void free;
- 15 breaking sufficient bubbles uniformly throughout the elastomer layer to make it compressible;
- 20 permanently laminating together the compressible elastomer layer and dimensionally stable reinforcing layer; and
- 25 laminating a layer of pressure-sensitive adhesive to each exposed major surface of the resultant structure.
- 30 18. A method substantially as described herein of forming a mounting material suitable for supporting a flexographic printing plate to the surface of a plate cylinder.

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COMPLETE SPECIFICATION

1 SHEET

*This drawing is a reproduction of  
the Original on a reduced scale*

FIG. 1

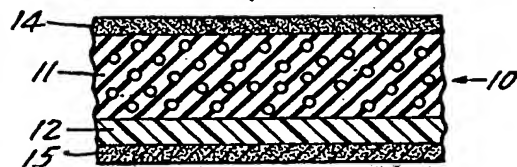
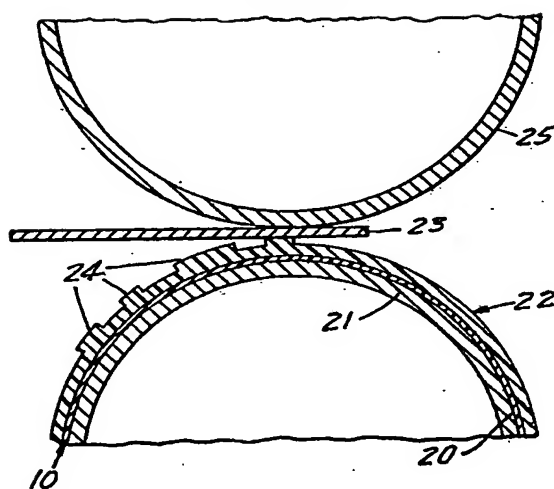


FIG. 2



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23.03.81-JP-042009 (27.09.82) B29c-23 B44c-01/20  
Mfg. decorative boards having a raised pattern - by printing raised pattern on sheet, applying releasing agent, resin, adhesive then resin coated sheet and hot pressing

In mfg. decorative boards a substrate sheet is printed with a raised pattern using a raising ink compsn. and the pattern is coated with a releasing agent to provide an embossed sheet. The embossed sheet is coated with a synthetic resin to uniformly fill the peaks and recesses of the raised pattern, and the surface of the substrate board is coated with an adhesive and laminated with the resin-coated sheet so that the adhesive layer is contacted directly with the resin layer. The laminate is then hot pressed and the embossed sheet is released from it to provide a decorative board having a raised pattern.

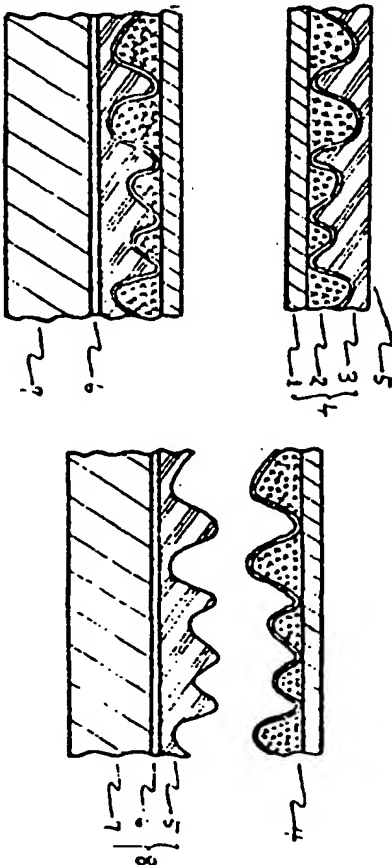
## ADVANTAGE

The process transfers a complementary raised pattern of an embossed sheet to a resin layer on a substrate board.

## DETAILS

The printing ink comprises a resin emulsion or paste (e.g. acrylate resin, rubber, PVC or vinyl acetate each

contg.  $\geq 40\%$  of solids and which can form a hard and compression resistant raised pattern). The releasing agent is typically silicone, polyethylene wax or protein opt. blended with rubber, cellulose acetate, aminoalkyd resin or urethane resin. The resin is typically urethane resin or synthetic rubber. The substrate board is typically polymer film, polymer sheet, paper, prepreg, cardboard, unwoven cloth, wood board or metal plate. (3pp W59).



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